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Crab-ripping: An Unusual Feeding Behavior Newly Recorded in Freshwater Snakes

Thanit Noonloy¹, Kirati Kunya², Lawan Chanhome³, Montri Sumontha⁴, Nirut Chomngam⁵ and Olivier S. G. Pauwels^{6,7}

Abstract

Snakes swallow their prey whole and their prey size is thus limited by their maximal gape, with exceptions being three scolecophidian snakes known to be able to decapitate termites, and two mangrove-dwelling snakes (Squamata: Homalopsidae: *Gerarda prevostiana* and *Fordonia leucobalia*) that are able to remove and ingest pieces from crabs. Here we present the first report of crab-ripping in a freshwater snake, based on observations made on adult Spencer's Mountain Keelbacks (Squamata: Natricidae: *Opisthotropis* cf. *spenceri*) tearing apart live, freshly molted Chaiphaphum Crabs (Decapoda: Potamidae: *Larnaudia chaiphaphumi*) in a mountain stream in Phetchabun Province, northeastern Thailand. Our observations represent the sixth documented report of arthropod-ripping in snakes, and the first for natricids and freshwater snakes.

Keywords

Aquatic ecosystems, biodiversity, herpetofauna, Crustacea, ecology, feeding behavior, carcinophagy, Thailand.

Introduction

Because snakes swallow their prey whole, the size of their prey is directly limited by the size of their gape. Only very rare exceptions to this universal rule are known. They are found in two coastal marine Southeast Asian snake species, the homalopsids *Fordonia leucobalia* (Schlegel, 1837) and *Gerarda prevostiana* (Eydoux & Gervais, 1837) (Shine and Schwaner, 1985; Jayne et al., 2002; Burbrink and Crother, 2011), and in three scolecophidian species (Mizuno and Kojima, 2015). The mangrove-dwelling monotypic genera *Fordonia* and *Gerarda* have a specialized crustacean diet, and are able to tear apart their prey's body parts and appendages. In addition to the analysis of stomach contents including crustacean pieces, ripping of freshly molted crabs, whose body is still soft, has been directly observed and documented in *Gerarda*.

During a biodiversity survey along an unnamed stream passing through dry forest and mixed deciduous forest in Thai Dong and Sap Poep subdistricts, Wang Pong District, Phetchabun Province, several of us made crab-ripping observations on an extremely rare snake species of the natricid genus *Opisthotropis* whose natural history was so far undocumented. These observations not only allow better understanding the ecology of this enigmatic snake, but also documenting a wider phylogenetic distribution of arthropod-ripping among snakes than previously thought. Given the importance of these observations, our team made several dedicated field visits to confirm whether this peculiar feeding behavior was occasional or a well-established natural history trait of this snake.

Materials and methods

Visits to the stream occurred on 17 February, 9 March, 5 May and 23 December 2015. Each visit lasted about 6 hours, from before to after dusk, and included portions of the stream located within or just outside Wang Pong – Chon Daen Non-hunting Area. Other species of reptiles and amphibians found in the stream were recorded and photographed. Our field team included four persons (LC, KK, NC and TN), all with previous experience in locating snakes in the field. Two adult snake individuals, collected outside the non-hunting area, were preserved whole in 70% ethanol as vouchers in the herpetological collections of the Queen Saovabha Memorial Institute, Thai Red Cross Society, in Bangkok (collection numbers QSMI 1163-1164). The crabs were identified by the crab taxonomist Rueangrit Promdam (Prince of Songkla University, Songkhla), using comparative material from the crustacean collections of the Chulalongkorn University Museum of Zoology in Bangkok and of the Prince of Songkla University.

Results

We encountered respectively two, four, three and two individuals of *Opisthotropis* cf. *spenceri* during each site visit. Based on the possession by both voucher specimens of a single prefrontal, seven supralabials, 17 smooth dorsal scale rows on the neck and at midbody, and contact between loreal and corresponding internasal, they are referable to *Opisthotropis spenceri* according to Teynié et al. (2013) and Wang et al. (2017). However, due to small differences in pattern and scalation, and

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Figure 1. Live adult *Larnaudia chaiyaphumi* crab in a mountain stream in Phetchabun Province, northeastern Thailand. Photograph by K. Kunya.

pending the results of our current analysis of the material available for this and closely related species, we presently refer to them as *O. cf. spenceri*.

All snakes were found within the stream, between 253 and 985 m asl. Young snakes were found at lower elevations than adults. From 900 m asl upwards, only adults were met. Snakes were observed where the streambed substrate is composed of rock and rough sand, in transparent slow-moving water, and where the water depth does not exceed 30 cm. Although the stream was surveyed during day and night, the snakes were only found at night, with an activity peak around 8–11:00 P.M. The snakes were hiding under rocks or moving underwater on the stream bottom in search of soft-shelled individuals of the Chaiphum Crab (Decapoda: Potamidae: *Larnaudia chaiyaphumi* Naiyanetr, 1982), obviously avoiding hard-shelled individuals (Figure 1). Once a soft-shelled crab was located, the snake coiled its body around it, and constricted it until the carapace was partly separated from the body, then plunged into the crab body to swallow soft internal parts (Figure 2). It then methodically pulled legs and the abdominal flap through a loop of its body until they broke, and swallowed them (Figure 3). Three distinct snakes were observed preying on crabs and showing the same feeding method, indicating that this prey and feeding behavior are usual for this species.



Figure 3. *Opisthotropis cf. spenceri* swallowing the abdominal flap of a *Larnaudia chaiyaphumi* crab in a mountain stream in Phetchabun Province, northeastern Thailand. Photograph by N. Chomngam.



Figure 2. *Opisthotropis cf. spenceri* penetrating into the body and swallowing soft parts of a *Larnaudia chaiyaphumi* crab in a mountain stream in Phetchabun Province, northeastern Thailand. Photograph by N. Chomngam.

Aquatic and riparian reptile species we found in syntopy with the *Opisthotropis* within the stream include *Platysternon megacephalum* Gray, 1831 (Platysternidae) (Figure 4), *Tropidophorus laotus* Smith, 1923 (Scincidae) (Figure 5) and *Hebius khasiense* (Boulenger, 1890) (Natricidae) (Figure 6; new province record, see Pauwels et al., 2009). Syntopic amphibians included *Limnonectes gyldestolpei* (Andersson, 1916) (Dicroglossidae), *Megophrys major* Boulenger, 1908 (Megophryidae) and *Odorrana livida* (Blyth, 1856) (Ranidae).

Discussion

Until recently *Opisthotropis spenceri* was known only from two specimens from Lampang Province in northern Thailand, without biological data (Pauwels, 2009; Pauwels and Chan-Ard, 2012). Chuaynkern et al. (2014) reported two more individuals collected in a mountain stream in the northern Thai province of Nan. Chan-ard et al. (2015) mentioned that the species is terrestrial, which is contradicted by its morphology and by our field observations and those of Chuaynkern et al. (see also the review on ecological aspects of Chan-ard et al. [2015] by Pauwels and Grismer [2015]). Our observations represent the first record of the species in northeastern Thailand.

Until now crab-ripping was unknown in non-homalopsid



Figure 4. Adult *Platysternon megacephalum* found in syntopy with *Opisthotropis cf. spenceri* in a mountain stream in Phetchabun Province, northeastern Thailand. Photograph by N. Chomngam.



Figure 5. *Tropidophorus laotus* found in syntopy with *Opisthotropis* cf. *spenceri* in a mountain stream in Phetchabun Province, northeastern Thailand. Photograph by N. Chomngam.

snakes and in freshwater snakes. It thus represents an important addition to the known feeding behaviors of Natricidae, which, although they are also included in the Colubroidea, are only distantly related to the Homalopsidae (Figuerola et al., 2016). The monotypic genera *Fordonia* and *Gerarda* are known to eat only crustaceans, which they can swallow whole or rip apart, depending on the prey size and shape (Murphy, 2007). Our observations represent the first diet record for *Opisthotropis* (cf.) *spenceri*, so it is not known if this snake has a specialized or exclusive carcinophagous diet. Chan (2011) observed in a small stream in Hong Kong an *Opisthotropis kuatunensis* Pope, 1928 with a freshly molted, dead *Cryptopotamon anacoluthon* (Kemp, 1918) (Decapoda: Potamidae) in its mouth, missing its chelae and most of its legs. Chan (loc. cit.) suggested that the snake possibly tore the missing parts off in the manner adopted by *Gerarda*, but could not confirm it because he did not actually observe this behavior. Karsen et al. (1998) noted that *Opisthotropis lateralis* Boulenger, 1903 feeds on “small shrimps, crabs and fish; possibly also on tadpoles,” without mentioning how crabs are eaten. Our new observations make it almost certain that Chan’s suggestion was correct, and crab-ripping might be practiced by several or all *Opisthotropis*, at least occasionally. Interestingly, the Lao common name of *Opisthotropis durandi* Teynié, Lottier, David, Nguyen & Vogel, 2013, is *ngu kung*, which means “shrimp snake,” and, although the diet of this species is still unknown, it was indeed found in small streams in syntopy with freshwater shrimps and crabs (Teynié et al., 2013). These authors did not explain in their article why the snake was called the “shrimp snake” by the locals, but it is in fact because they claim that it eats shrimps (A. Teynié, pers. comm. to OSGP, March 2017). Other *Opisthotropis* have accepted fish and earthworms in captivity (Karsen et al., 1998; Wang et al., 2017). The dietary habits of the monotypic genera *Isanophis*,



Figure 6. Adult *Hebius khasiense* found in syntopy with *Opisthotropis* cf. *spenceri* in a mountain stream in Phetchabun Province, northeastern Thailand. Photograph by N. Chomngam.

Parahelicops and *Paratapinophis*, also living in mountain streams in Southeast Asia and supposedly closely related to *Opisthotropis*, are still unknown, except for digested fish remains found in two *Paratapinophis* (Murphy et al., 2008; David et al., 2015). Freshwater snakes represent about 5% of all extant snakes and are found in diverse families and regions (Pauwels et al., 2008). The diet of many of them is poorly known, with no information available in many species, and it is very possible that carcinophagy and crab-ripping are widespread among aquatic snakes.

The freshwater crab *Larnaudia chaiyaphumi* is endemic to Thailand and shows a very localized distribution, centered around Phu Khieo in Chaiyaphum and Phetchabun provinces where it lives in forest streams; its conservation status is currently regarded as of least concern (LC) by the IUCN (Esser and Cumberlidge, 2008; present observations). Our new locality record within a protected area reinforces its LC status.

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Additional Mudpuppy (*Necturus maculosus*) Records from Fisheries Assessment Surveys Conducted in Wisconsin

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Introduction

The underwater and primarily nocturnal behavior of mudpuppies (*Necturus maculosus*) poses challenges when trying to understand the species' distribution and status. Thus, conservation practitioners may need to rely on less traditional data sources. One such source of potentially useful information for the mudpuppy is the incidental captures made during routine fisheries assessment surveys. Along these lines, Watermolen (2015) recently outlined published records documenting the Wisconsin distribution of mudpuppies and presented additional observations, based largely on fisheries management activities, that confirmed and supplemented several previous reports. He also reported observational data from six additional counties from which mudpuppies had not previously been documented. Since then, Wisconsin Department of Natural Resources (DNR) fisheries biologists have encountered mudpuppies in several additional counties and water bodies during their routine fisheries management activities. As a result, the agency's Fishery and Habitat Biology Database now includes more than 200 records of mudpuppy captures from more than 30 water bodies statewide. Following up on Watermolen's (2015) suggestion that natural resources agencies benefit from making unpublished data more widely available for conservation purposes, I summarize below some of the more significant data from these Wisconsin DNR fisheries activities and place the observations in the context of previous reports to provide a more complete picture of this species' distribution in Wisconsin.

Records

Barron County—Confirmation of county record—Vogt's (1981) map depicts a specimen record for this species in far northern Barron County, but more recent investigators have been unable to locate a voucher to substantiate it. A record for this county, however, is now supported by a voucher photograph (Figure 1) that has been deposited in the Milwaukee Public Museum's collection (MPM VZP #898). The mudpuppy was captured by a Wisconsin DNR fisheries crew working on Lake Chetek (45.31°N, 91.62°W) on 02 September 2015.

Bayfield County—Unusual habitat record—Nearly all mudpuppy observations in Wisconsin come from rivers and large lakes (i.e., >100 acres, unpubl. data) with ample protective cover and suitable nesting sites. As such, I was surprised to learn that Wisconsin DNR fisheries biologists encountered mudpuppies in a relatively small seepage lake with apparently little suitable habitat and sizable populations of predatory fish. The biologists captured mudpuppies in fyke nets set in Pike Lake (46.53°N, 91.37°W) in April 2016. Pike Lake is the smallest Wisconsin lake (19 acres, maximum depth = 23', mean depth = 8') in which mudpuppies have been encountered (unpubl. data).

The lake's bottom is 88% muck and 12% gravel, a composition that suggests it would be unsuitable habitat for mudpuppies, which typically occupy waterbodies with an abundance of cover objects (e.g., stones typically larger than gravel) (Smith, 1911; Sajdak, 1982). Even more unusual is the fact that Pike Lake has significant populations of muskellunge (*Esox masquinongy*) and northern pike (*E. lucius*), generalist predators that could limit mudpuppy populations significantly in the absence of adequate protective cover.

Burnett County—Clarification and confirmation of county record—The exact location of the voucher on which Casper (1996) based his first report of mudpuppies from Burnett County has been unclear due to confusing locality information associated with the specimen. The information for specimen MPM 820, which was collected in July 1909, identifies the collection location as "Pansy." Modern maps of Burnett County do not depict any features with the name Pansy and the U. S. Geological Survey's Geographic Names Information System (USGS, 2017) includes no records for a feature named Pansy in Wisconsin. A recent search of the online Dictionary of Wisconsin History (WHS, 2017), however, yielded a result that helps resolve the confusion. The historical place Pansy was located "4 miles north of mouth of Yellow River" (46.00°N, 92.21°W) in Burnett County. Given the local geography, this suggests the specimen was likely captured in the St. Croix River. Anglers have previously noted the presence of mudpuppies in the St. Croix (Niskanen, 1996), and the mudpuppy's presence in Burnett County is further substantiated by Wisconsin DNR fisheries biologists who collected three mudpuppies from Lipsett Lake (45.87°N, 92.04°W) on 28 March 2016 and an additional specimen from the same lake the following day.

Eau Claire County—Additional locality records—Casper (1999) documented the first record from this county based on a



Figure 1. Mudpuppy collected from Lake Chetek, Barron County, Wisconsin, 02 September 2015. MPM VZP #8898.

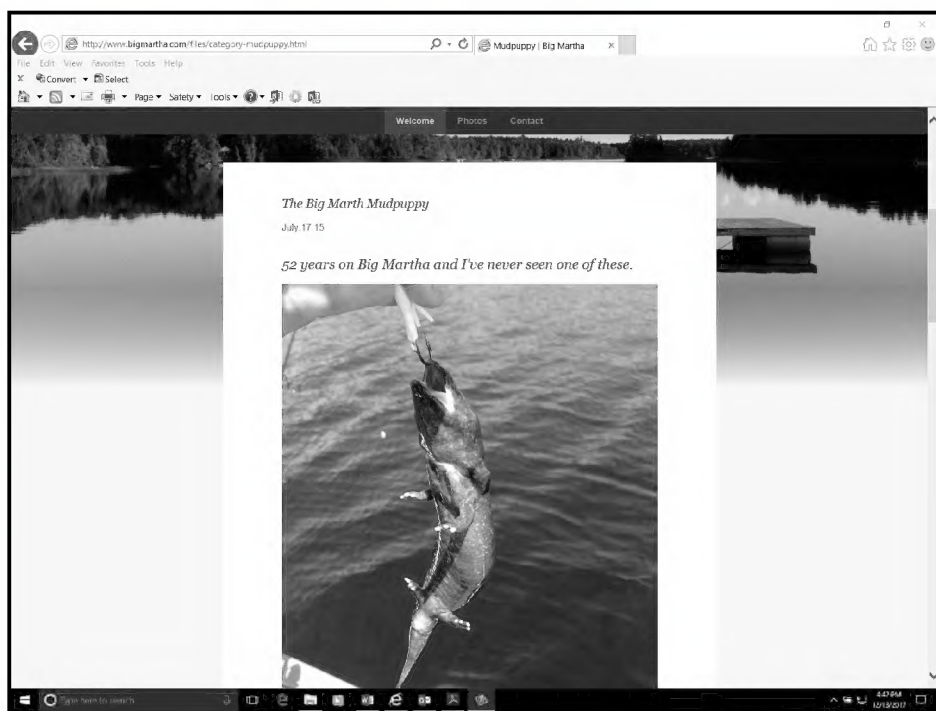


Figure 2. “The Big Marth Mudpuppy” blog post showing a mudpuppy caught by an angler on Martha Lake, Iron County, Wisconsin (Krumdick, 2015).

specimen caught by an angler who was fishing on the Chippewa River in May 1997. Local newspapers also mention mudpuppies being caught in the Chippewa River (e.g., Reiter, 2017) and they have been observed during freshwater mussel surveys in both the Upper and Lower Chippewa River (Balding, 1992; Balding and Balding, 1996). Wisconsin DNR records indicate that mudpuppies occur elsewhere in Eau Claire County as well. Fisheries biologists captured a single mudpuppy in Black Creek (44.43°N, 91.02°W) using an electrofishing device on 13 August 2015. Four additional mudpuppies were caught in fyke nets set in Altoona Lake (44.81°N, 91.42°W) in April 2016 and three more were taken in nets in the same lake in April 2017.

Green Lake County—Continued presence in Green Lake—Mudpuppies have long been known to occur in Green Lake (43.81°N, 89.00°W; Pope, 1930). Hacker (1957) found lake trout (*Salvelinus namaycush*) eggs in 70 percent of the 150 mudpuppies that he trapped over spawning areas in the lake in the fall of 1953. Based on his observations, he attributed the lack of reproduction by this introduced species to mudpuppy predation on its eggs, a belief that was reported in numerous newspaper accounts over many years (e.g., Pyre, 1954; Anonymous, 1964). Westover (1962) even commented that “A batch of trout eggs is just caviar to a mud puppy. Without protection on the mud bottom where the stupid trout persisted in laying their eggs, the entire batch is doomed to be consumed in about 30 days.” The placement of rocky substrates over the lake bottom, however, provided protective cover for the fish eggs and fry allowing for successful trout reproduction and recruitment (Anonymous, 1956, 1958; Hacker, 1957). Mudpuppies remain common in this lake and are occasionally caught by anglers (Dunn, 1962; Harp, 1968). Bachay’s (1966a) account even includes a photograph of an 11.5 in. long mudpuppy taken by an angler. A total of 235 mudpuppies were caught in fyke nets placed in Green Lake in April and May 2016. Lake trout also continue to be stocked and are common in the lake (Wisconsin DNR, unpubl. data).

Iron County—Additional water body records—Watermolen (2015) commented on some limitations associated with the information included in Casper’s (1997) first report of

mudpuppies from Iron County. Subsequent review of information associated with the voucher photographs (MPM VZP-576a-b) indicates the specimen was captured in Trude Lake (46.11°N, 90.15°W) as speculated by Watermolen (2015). Watermolen (2015) also provided observational records from two additional Iron County waterbodies. Records of mudpuppies from elsewhere in the county are available from recent Wisconsin DNR fisheries efforts. In April 2016, mudpuppies were collected by fyke net in Pike Lake (46.17°N, 90.11°W) and the Turtle Flambeau Flowage (46.07°N, 90.17°W). In addition, a 2015 Internet blog post (Figure 2; Krumdick, 2015) included a photograph of a mudpuppy that had been caught by anglers on Martha Lake (46.17°N, 90.03°W).

Marinette County—Additional locality records—Casper (1996) documented the first vouchers for mudpuppies from this county, but several paper and utility companies had previously reported mudpuppies from the Menominee River along Marinette County’s border with Michigan as part of their hydroelectric dam relicensing applications (Niagara of Wisconsin Paper Corporation, 1991; WEPCO, 1991; WPS, 1991; FERC, 1996). Watermolen (1996) also described a case of an osprey (*Pandion haliaetus*) preying on a mudpuppy on the Lower Menominee, and there are newspaper accounts of the species being caught farther upstream (Anonymous, 1930; Bachay, 1966b). Mudpuppies occur elsewhere in Marinette County as well. Caroffino et al. (2010) reported mudpuppies consuming lake sturgeon (*Acipenser fulvescens*) eggs in the lower Peshtigo River below the Peshtigo dam. Farther upstream, a specimen (MPM 33377) was captured “just downstream of the Potato Rapids Dam” in October 2003. A specimen in the Ohio State University Museum (OSUM 4145) was collected nearby at the State Highway 64 bridge in July 1969. An additional mudpuppy (OSUM 4142) was collected the same day several miles upstream at the County Highway W crossing. Wisconsin DNR fisheries biologists captured mudpuppies on 11 and 13 April 2015 while working on the Johnson Falls Flowage (45.26°N, 88.17°W), demonstrating that the species occurs considerably farther upstream in this river system.

Oneida County—Additional water body records—Casper (1996) first reported mudpuppies from Oneida County based on a specimen (MPM 12452) collected from the Pelican River during a Wisconsin DNR fish distribution study in August 1975. Wisconsin DNR records indicate mudpuppies occur elsewhere in Oneida County as well. Fisheries biologists collected mudpuppies from Kawaguesaga Lake (45.86°N, 89.73°W) on 17 April 2015 and Boom Lake (45.65°N, 89.41°W) on 13 May 2015. Twenty-six mudpuppies were caught in fyke nets placed in Minocqua Lake (45.87°N, 89.69°W) on 15–19 April 2015. Two additional Minocqua Lake mudpuppies were taken by electrofishing on 19 April 2015. In addition to these records, Rhinelander is listed as the collection locality for a series of 11 larval specimens collected in May 1950 and now housed in the University of California-Berkeley’s Museum of Vertebrate Zoology (MVZ 52646-52656). Although the collection information does not include a water body name, these specimens were likely collected in the Wisconsin River.

Shawano County—Additional water body records—Casper

(1996) first reported mudpuppies from Shawano County based on a specimen that a Wisconsin DNR fisheries manager collected while working on White Clay Lake (44.80°N, 88.40°W) in April 1994. Additional records are available from more recent Wisconsin DNR fieldwork. Fisheries biologists captured 29 mudpuppies in fyke nets placed in Shawano Lake (44.80°N, 88.51°W) on 14–18 April 2016. Additional mudpuppies were caught on the Cloverleaf Chain (Round, Grass, and Pine lakes; 44.69°N, 88.66°W) on 15 April 2017 and the Wolf River on 31 March 2016 and 6 April 2016. A photographic voucher taken in August 1992 from the Wolf River at the County Highway A crossing is also available (MPM VZP-540).

Waushara County—Additional observational records—Records supported by vouchers have not been available from Waushara County, but Watermolen (2015) reported a fisheries technician's observations from Long Lake (44.21°N, 89.12°W). Wisconsin DNR fisheries crews also collected mudpuppies with a fyke net used in Lake Morris (44.11°N, 89.20°W) on 10 April and 12 April 2017. Further efforts should be made to obtain a voucher specimen from this county.

Wood County—New county record—Mudpuppies have not previously been reported from Wood County. On 14 April 2015, Wisconsin DNR fisheries biologists captured a single mudpuppy with a fyke net placed in the Wisconsin Rapids Flowage (44.40°N, 89.81°W). Further efforts should be made to obtain a voucher specimen from this county.

Discussion and Conclusions

Mudpuppies occur in rivers and lakes throughout Wisconsin. Information gleaned from fisheries assessment surveys can enhance our understanding of mudpuppy distribution and status (Hoffman et al., 2014; Craig et al., 2015; Watermolen, 2015). The above observations fill gaps in the mudpuppy's known Wisconsin distribution. When considered alongside museum specimens and published records, these unvouchered but reliable field data collected by trained biologists provide a more complete picture of the occurrence and status of this species and provide insights into its habitat use. These additional field data both confirm and expand the available information. Continued documentation of incidental encounters with mudpuppies as part of routine fisheries management work will have value for conservation planning and management of this species. Such work could also yield vouchers for poorly documented localities.

Acknowledgments

Lori Tate mined the Wisconsin DNR's Fishery and Habitat Biology Database and shared mudpuppy captures documented by Bureau of Fisheries Management biologists. Julia Colby provided information associated with voucher specimens housed in Milwaukee Public Museum's collection. I appreciate these colleagues' efforts to help me document this species. Additional specimen collection information was gleaned from VertNet.org and reflects the efforts of curators at the respective institutions.

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Flipping Pages: Appreciations of Herpetological Literature
Reptiles and Amphibians: A Golden Guide to Familiar Species (1953)
by Herbert S. Zim and Hobart M. Smith

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I am at a loss to explain my general interest in wildlife and nature: I have no memory of not being interested in birds and bugs and things found under rocks. But I do remember where and when my interest in reptiles crystalized: sitting on the floor of the church library at Hobart Methodist Church in Minneapolis, after Sunday school, while my father, the Sunday school treasurer, counted the pennies and nickels the classes had given. In the library, a small room not much larger than a janitorial closet, was a whole shelf of Golden Nature Guides covering a wide range of subjects: birds, mammals, trees, stars, etc., but the one I took off the shelf and began reading (I think I was five or six) was Zim and Smith's guide to reptiles and amphibians. Perhaps the cover drew my attention: a Collared Lizard, an Ornate Box Turtle, a Coral Snake, a Banded Gecko, a frog, and a salamander.

The Golden Nature Guides are probably as much responsible for creating an interest in nature among Baby Boomers as are the Peterson Field Guides. The Golden Guides were small (I recall taking one or two along on my "expeditions") and rela-

tively inexpensive: originally, I think, they cost fifty cents, but it might have been as much as a dollar. The series founder and editor, Herbert S. Zim, intended the guides to be introductions to science and the natural world for elementary students, but for many people interested in nature, they were the most readily available nature books. Lending authority to the book was its co-author, Hobart M. Smith. Smith is often credited with being the most prolific herpetological writer of all time; he has 1600 publications to his credit, 29 of which are books! Smith was an authority on Mexican herptiles, but from 1947 through 1968, he taught at the University of Illinois and is responsible for the collection of reptiles and amphibians at the university's natural history museum.

The nature guides' format was uniform: some general front matter, then species-by-species accounts of the animals and plants the book covered. The animals and plants were illustrated with colored pictures of the subject in a natural setting, and in the bottom right of the page was a range map. To me, those range maps were something akin to Divine Truth. If the map

showed a snake's range in Minnesota, then I expected to find it in the vacant lots that still made up part of the landscape in Minneapolis. When my parents took us on a picnic to Lake Harriet, one of the many lakes within the city's limits, I expected to see the turtles and frogs and salamanders the range maps indicated inhabited the region. When I needed evidence that snake envenomation was not a concern in Minneapolis, I could show Mother the Copperhead and Timber Rattlesnake maps, both snakes conspicuous by their absence from the greater Minneapolis region. (As it turned out, the maps were better indicators of what I would not find than what I would.)

For the most part, species are presented in pairs or groups: "Tree Frogs" includes eight species, while "Bullfrog and Green Frog" are paired. The species descriptions are pretty basic and straightforward. Painted Turtles are first described as "perhaps the most common and widespread of turtles" and are "easily identified by their broad, dark, flattened smooth-edged shells." Life history notes are also included: diet ("water plants, insects, and other small animals . . ." as well as behavior notes ("shy"; "not easily captured"). An illustration of two turtles on a log (Eastern and Midland) occupies the top halves of two pages, while the text, illustrations of two other subspecies (Western and Southern), and the range map take up the rest of the space. Some groups, such as treefrogs, are discussed as a group, but individual species, along with their range maps, are shown in one- and two-page spreads.

The illustrations were by James Gordon Irving; Irving was a commercial artist who painted the covers of several Nature Guides, including *Insects*, *Fishes*, and the original *Stars*. Besides doing the cover, he also illustrated the *Birds* volume in the series. Maybe it's just the reprints, or maybe it's me, but some of the illustrations strike me as dark, and not just because the images could be brighter. The turtles, lizards, frogs, and salamanders look natural enough, and because they usually represent the more common species, serve as an aid to identification. Snakes are something else, though: the curvature of the mouth on some (the Brown Vine Snake is an example) strikes me as a silly grin, while the glaring eyes of others (the Rat Snakes) seem especially malevolent. And although it was probably not Irving's doing, most of the text descriptions did not do a whole lot to distinguish one species from another: that required closely studying the illustrations.

My copy of *Reptiles and Amphibians* disappeared over time, but the book is still available. Used copies — some costing as much as fifty dollars! — are available on-line. A more affordable alternative is the reprint, also available on-line from St. Martin's

Press. It is interesting to note that while some sections of the book have been revised and updated, the scientific names are strictly old school taxonomy: toads are *Bufo* and Rat Snakes are *Elaphe*. What has definitely been updated is the first aid for snakebite. No longer are readers told to apply a tourniquet, cut the bite, and suck out the envenomed blood. Instead, after a warning that first aid measures may do more harm than good, the recommended protocol is to apply a constriction band (three or four inches above the bite; loose enough so that a finger can be inserted; between the bite and the heart) and to seek medical attention. Readers are told not to apply a tourniquet and cut the wound.

Another update is the references. Most of them are from the late 1990s, including Collins's edition of Conant's *A Field Guide to Reptiles and Amphibians*. What I find amusing is what the book says about web sites: "The web is full of interesting information about reptiles and amphibians." I appreciate the understatement. The Savannah River Ecology Laboratory's site (www.uga.edu/srelherp/) is singled out as a good site to begin, although one would wish the Chicago Herpetological Society's were also included. Readers are advised what would be good search words to use to conduct a search; speaking as someone who has tried to teach tech-savvy youngsters how to research a topic, I appreciate the suggestions. My own relatively recent attempt to find out about the care of Russian Tortoises came up with 692,000 possible sites, so I was busy that weekend.

I have to ask myself: Is this book still relevant? Amazon offers close to 15,000 titles if one searches for "reptiles" in the book section. "Reptile books for kids" alone comes up with 2,700 titles! A digression concerning the latter: The Golden Nature Guide does not show among those title, even though its original target audience was elementary students; on the other hand, there are at least a half dozen field guides that, while an elementary student could probably use them, are meant for adults. And the classic book by Moore and Williams, *The Snake That Went to School*, is not included among the 2,700, even though other novels are (including one about a turtle and the tooth fairy, which raises several provocative questions, starting with, since when do turtles have teeth?). But back to the book's relevance: in a word, yes, it is relevant, and not just for children. It focuses on the species one is most likely to see; every species I have seen from northeastern Illinois is included. It is inexpensive. It is (except perhaps in matters of current nomenclature) accurate. And most importantly, it is capable of creating and nurturing an interest and affection for animals often detested and persecuted.

Emergency Aquatic Turtle Shell Repair

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During the course of a long-term turtle capture-mark-release program in Oceana County, Michigan, an adult female midland painted turtle, *Chrysemys picta marginata* was captured on 5 June 2016. The plastron of this 320-g turtle had recently been fractured at the humeral–gular suture line on the left side. The lateral bridges connecting the carapace and plastron were not damaged. The shell lesion was filled with freshly clotted blood, but otherwise the turtle behaved normally. The turtle was given emergency medical care including cleaning and disinfection of the fracture. The site was dried, and bleeding stopped with pressure. It was necessary to seal the fracture after realigning the plastral edges. Given the remote location of the study site, the only available source of shell repair material was a large retail chain store where Repair-It® [Majestic Drug Company Inc., South Fallsburg, NY 12779], a human emergency dental repair kit was available.

Following product instructions, the dental acrylic powder and solvent were mixed to the consistency of thick creamy cereal. The edges of the plastron break were aligned and firmly pressed together and the prepared acrylic placed in and on the shell lesion. The acrylic was smoothed by hand and pressure continued until hardened.

To permanently set this type of dental acrylic, it is necessary to soak the repair in hot but not boiling water for a full ten minutes. Because this product is intended for human denture repair, this usually presents no difficulty. In the case of a living turtle it is not so easily accomplished. As an alternative, the turtle was placed on its back and hot tap water dripped continuously on the repair site without affecting any of the adjacent front limb soft tissue. At the end of the prescribed hardening time the turtle was held overnight in a dry container before

being marked and released at the capture site.

The treated turtle was recaptured nearly four months later on 28 September and at that time weighed 342 g, an increase of 20 grams. The dental patch was still in place and the plastral fracture appeared to be healed.

The literature provides a range of veterinary solutions for shell fractures in turtles, both freshwater and marine. Most emphasize an understanding of turtle shell anatomy and provide a step by step process for evaluation and treatment. (Fleming, 2008; Jarons, 2009; Villa, 2009a, b; Joy et al., 2010; Melidone and Selleri, 2010). Materials used in shell repair range from dental acrylic to elaborate zip tie and epoxy applications (Villa, 2009c; Long, 2013). A helpful general guide to emergency reptile and invertebrate care by Erica Mede can be downloaded from the CHS website.

Roads and speeding vehicles represent one of the single largest threats to the survival of freshwater turtles, especially those like the painted turtle that often migrate across roadways to reach their preferred breeding locations. This turtle was in all likelihood one of those victims.

Acknowledgments

Alicia and Bill Kolenda and their family allowed access to the study site and assisted in this effort. The state of Michigan, Department of Natural Resources, Fisheries Division, Aquatic and Regulatory Affairs Unit, issued a Scientific Collector's Permit to allow this study. Gail Meritt assisted in various ways. Thanks are due each for their contributions to this study and on-going work.

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Notes on Reproduction of Eastern Spadefoot Toads, *Scaphiopus holbrookii* (Anura: Scaphiopodidae)

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Abstract

A histological examination of gonads of 52 eastern spadefoot toads, *Scaphiopus holbrookii* from the eastern United States was conducted. Unlike other temperate zone anurans *S. holbrookii* is not restricted to reproducing within a few months. I found *S. holbrookii* males in breeding condition (sperm production) throughout the year; females in spawning condition were present in all months examined, from April to December (except March, n = 1). This supports previous statements that *S. holbrookii* breeding may occur almost any time of the year (Beane et al., 2010). The smallest mature male (sperm in lumina of seminiferous tubules) measured 44 mm. The smallest mature female (in spawning condition) measured 48 mm SVL.

Scaphiopus holbrookii (Harlan, 1835) occurs in southern New England through Florida, west to southeast Missouri and eastern Arkansas (Powell et al., 2016). The biology of *S. holbrookii* was summarized by Wasserman (1968) and Palis (2005). In my current paper I present data from a histological examination of *S. holbrookii* gonads from the eastern United States. Utilization of museum collections for obtaining reproductive data avoids removing additional animals from the wild.

A sample of 52 adult *S. holbrookii* collected 1939 to 1997 consisting of 32 males (mean SVL = 58.3 ± 5.4 SD, range = 44–68 mm) and 20 females (mean SVL = 59.4 mm ± 5.9 SD, range = 48–74 mm) was examined from the herpetology collections of the Carnegie Museum (CM), Pittsburgh, Pennsylvania, USA and the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA (Appendix). The *S. holbrookii* came from the following states: Florida (n = 2), North Carolina (n = 2), Virginia (n = 39), West Virginia (n = 9). An unpaired *t*-test was used to test for differences between adult male and female SVLs (Instat, vers. 3.0b, Graphpad Software, San Diego, CA).

A small incision was made in the lower part of the abdomen and the left testis was removed from males and a piece of the left ovary from females. Gonads were embedded in paraffin, sections were cut at 5 μm and stained with Harris hematoxylin followed by eosin counterstain (Presnell and Schreiber, 1997). Histology slides are deposited in CM and LACM.

There was no significant size difference between means of male and female body sizes (*t* = 0.68, *df* = 50, *P* = 0.50). The testicular morphology of *S. holbrookii* is similar to that of other anurans as described in Ogielska and Bartmańska (2009a). Within the seminiferous tubules, spermiogenesis occurs in cysts which are closed until the late spermatid stage is reached; cysts then open and differentiating sperm reach the lumina of the seminiferous tubules (Ogielska and Bartmańska, 2009a). The histology of the seminiferous tubules remained similar throughout the year. The cysts containing maturing sperm were gone, apparently having emptied their sperm into the lumina of the seminiferous tubules. Dense packets of sperm were the most frequently seen cells in the seminiferous tubules. In some cases intertwined sperm masses were also observed in the central lumina. This condition was seen in all males: January (n = 1),

February (n = 2), March (n = 3), April (n = 5), May (n = 6), June (n = 5), July (n = 3), August (n = 2), October (n = 3), November (n = 2). These observations indicate *S. holbrookii* males can breed throughout the year. The smallest mature male in my study (undergoing spermiogenesis) measured 44 mm SVL (CM 36535) and was from February. Wright and Wright (1949) reported males of *S. holbrookii* were mature at 54 mm.

The ovaries of *S. holbrookii* are typical of other anurans in being paired organs lying on the ventral sides of the kidneys, which in adults are filled with diplotene oocytes in various stages of development (Ogielska and Bartmańska, 2009b). Mature oocytes are filled with yolk droplets; the surrounding layer of follicular cells is thinly stretched. Monthly stages in the ovarian cycle of *S. holbrookii* are in Table 1. Three stages were present: (1) “Spawning condition” in which mature oocytes predominated; (2) “Recently spawned” in which corpora lutea (= postovulatory follicles) from a recent spawning predominated. Corpora lutea form when the ruptured follicles collapse after ovulation. The follicular lumen disappears and the proliferating granulosa cells are surrounded by a fibrous capsule (Redshaw, 1972). Postovulatory follicles are short-lived in most anuran species and are resorbed after a few weeks (Redshaw, 1972); (3) “Not spawning.” One female from March exhibited a massive follicular atresia in which all yolk containing maturing were filled with brownish pigment. Atresia is a widespread

Table 1. Monthly stages in the ovarian cycle of 20 adult females of *Scaphiopus holbrookii*.

Month	n	Spawning condition	Recently spawned*	Not spawning**
March	1	0	0	1
April	2	1	1	0
May	4	3	1	0
June	1	1	0	0
July	3	3	0	0
August	2	2	0	0
September	2	2	0	0
October	2	2	0	0
November	2	2	0	0
December	1	1	0	0

* postovulatory follicles

** atretic oocytes predominate

Table 2. Months of breeding by state for *Scaphiopus holbrookii*.

State	Times of breeding	Source
Alabama	Spring, summer or any month	Mount, 1975
Arkansas	February, March	Trauth et al., 1990
Connecticut	June, July	Klemens, 1993
Florida	March, April, August, September, October	Pearson, 1955
Georgia	Any month of year	Jensen et al., 2008
Illinois	April to September	Phillips et al., 1999
Indiana	Spring or summer*	Minton, 2001
Kentucky	March to September*	Barbour, 1971
Louisiana	February to July	Dundee and Rossman, 1989
Missouri	February, April to August	Johnson, 2000
Pennsylvania	April, July, August	Hulse et al., 2001
Rhode Island	1982, 1989, exact dates not given*	Klemens, 1993
West Virginia	March through October	Green and Pauley, 1987
Not given	March to September	Oliver, 1955

* breeding may not occur if conditions are not favorable.

phenomenon occurring in the ovaries of all vertebrates (Uribe, 2009). It is common in the amphibian ovary (Saidapur, 1978) and is the spontaneous digestion of a diplotene oocyte by its own hypertrophied and phagocytic granulosa cells which invade the follicle and eventually degenerate after accumulating dark pigment (Ogielska and Bartmańska, 2009b). Atresia is a significant factor in fecundity by reducing the number of ovulated oocytes (Uribe, 2011). Incidences of follicular atresia increase late in the reproductive cycle when yolking follicles that did not ovulate are resorbed (Goldberg, 1973). Saved energy will presumably be utilized in a future reproduction. Occasional atretic follicles were noted in 14/17 (82 %) female *S. holbrookii* in spawning condition (Table 1). The smallest mature female in my study (spawning condition) measured 48 mm SVL (CM 16871) and was from April. Wright and Wright (1949) reported females of *S. holbrookii* were mature at 50 mm SVL.

Unlike other temperate zone anurans which have a restricted breeding season (Mizell, 1964; Schroeder, 1974; Ko et al.,

1998), *S. holbrookii* may breed almost any time of the year under suitable environmental conditions (Beane et al. 2010; Bartlett and Bartlett, 2011). This is supported by my finding of sperm-producing *S. holbrookii* males throughout the year and females in spawning condition from April to December (Table 1). *Scaphiopus holbrookii* reproduction follows heavy rains (Gosner and Black, 1955; Pearson, 1955; Phillips et al., 1999) is “explosive” and is completed in one or two nights (Hulse et al., 2001). Gosner and Black (1955) described *S. holbrookii* reproduction as “spasmodic and unpredictable.” No reproduction occurs if weather is unfavorable (Beane et al., 2010; Bartlett and Bartlett, 2011). Nevertheless, most reports of *S. holbrookii* breeding are from spring and summer (Table 2). A more extensive list of *S. holbrookii* breeding dates is in Hansen (1958).

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Appendix

Scaphiopus holbrookii from Florida, North Carolina, Virginia and West Virginia counties examined from the herpetology collections of the Carnegie Museum (CM), Pittsburgh, Pennsylvania, USA, and the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA. **Florida:** Miami-Dade LACM 59460, 59463; **North Carolina:** New Hanover CM 37376; Wayne CM 73421; **Virginia:** Bridgewater CM 16871; Caroline CM 155319; Cumberland CM 152222, 152952; Gloucester CM 11413; Hopewell CM 340350; James City CM 22733, 32312–32314, 32366, 36535, 35460, 35462, 35463, 35469–35471, 36381–36383, 35461, 60169; New Kent CM 31292; Radford CM 17632, 17634; Rockingham CM 12035; Southampton CM 126371; Suffolk CM 127199, 127200, 127209; Surry CM 127580, 127584, 127583, 127586, 127589, 127592; Williamsburg, CM 35466, 35472; **West Virginia:** Cabell CM 17288, 17295–17297, 17299; Wayne CM 19461, 43533, 43535, 43536.

The Night of “Who’s Tracking Whom?”

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24 August 2006

Darkness envelops the surroundings, hanging over the landscape like a moist black velvet curtain. No moon casts light over the Suizo Mountains, and low-lying clouds have blotted what little light the stars might cast. There are no silhouettes on the horizon to navigate by. It’s as black as it gets in this remote stretch of the Sonoran Desert. As is often the case, the Tracker works alone tonight. The ride in has been harrowing, and he is all sorts of rattled by the events that have led to this moment. He really doesn’t want to be doing this. It’s muggy, it’s buggy, and it’s *spooky*! But the mother *atrox* are all birthing, and the only way to be one with the experience is to be there to witness it. Very shortly, the wee ones will shed their skins, and clear out from one particular mother’s nest. To snooze is to lose. He can sleep when the ink is drying on the datasheets.

The roads leading to this place have all been obliterated by the summer rains. It was an adventure in terror just getting here. Mucking through puddles two feet deep on muddy roads in a two-wheel-drive pickup has left his guts in a knot—his undies are an elastic boa constrictor. And he still has the return trip to survive. He tells himself that the day will come when he is glad that he did all these things while he could. But tonight, he is not happy to be here.

Perched on top of Li'l Hill, he dials in his receiver to a frequency of 540. He hears the familiar blips, waves the antenna about, triangulates the direction of the blips, and notes that the signal indicates that she has *finally* moved from her presumed nest site. For over three weeks, to the monotonous music of static and blips, he has tracked her to the same mundane prickly pear patch. With each tracking session, all he sees is a thorny clump of ouch, with a few soil holes cryptically contained beneath the stalks of the pernicious and onerous plant. Just looking into the depths of each hole requires a dangerous contortionist act. He has to wade crotch deep into spiny nastiness, bending over and amidst the miserable, meter-tall “stab yuh-jab yuh” plant porcupine. The view afforded with each painful effort is always the same: nothing but rat turds scattered about inside a series of soft-soiled holes. Adding to the misery is the fact that neither this *wench* of a snake, nor any possible neonates of hers, are *ever* visible. So, with each tracking episode, he writes down her body temperature, microclimate information, GPS location—15-minutes-worth of scrawling against a clipboard. And when all is said and done, the real piece of info collected remains the same: “Not visible, soil holes with rat turds scattered inside, center of prickly pear.” There just aren’t a whole lot of creative ways to write up soil holes with rat turds inside. Recording the nesting habits of female *Crotalus atrox* # 102, also known as “Ali,” has been a very frustrating and boring experience.

It appears that tonight will be different. The signal indicates that she has *finally* moved. It is time for him to do the same. The Tracker plunges down the side of Li'l Hill, following the blips, and dodging big clumps of harsh plant life that spring up into his pathway. The cholla aren’t jumping tonight—but they are

rattling their sabers menacingly. At length, the game of vegetable dodge ball is behind him. The cholla forest wanes in density, and Ali is found coiled on open, stony bajada (Figure 1). Goodie! He gets to write something different tonight! “Coiled in hunt posture on open bajada, nothing but spurge and bursage within one meter.” Wow! That’s a *geyser*. A bottomless pit of knowledge, eloquently phrased. But in the most holy of holy places on the datasheet, he writes the two words that mean the most: “Has dropped.” Those two words are his abbreviated way of saying “parturition has occurred.” In other words, she has given birth, or in slang, has dropped her kids.

At his approach, Ali is coiled tightly in a standard hunt posture. Head is resting on foremost coil, her neck cocked in an S-shape, a grayish-brown cow-pie on the stony substratum. As he draws closer, she flinches uneasily several times. She of course knows that he has arrived. (“Oh—it’s *you* again.”) She doesn’t quite know what to do about it. Moments later, she is spooked enough to break ranks, and begins to crawl slowly away in a northeasterly direction. While the rear third of her body is lean, there aren’t any dorsolateral folds that would indicate emaciation (Figure 2). To be sure, she has given birth, but it didn’t take everything out of her to do so. In short, mamma is going to be all right.

Conventional wisdom regarding parturition in rattlesnakes would indicate that the mothers stay with the young until their first shed. Following that, they all go their separate ways. Ali is now well away from her nest site, which would serve to indicate that her young have likely shed and left the nest site as well. Having thusly jumped to conclusions, a decision to visit Ali’s god-awful nest site one more time occurs. There is a strong possibility that neonate shed skins can be found there. If any are discovered, they will be collected, bagged, and carefully labeled for later DNA analyses. The fumbling, bumbling flandickery it

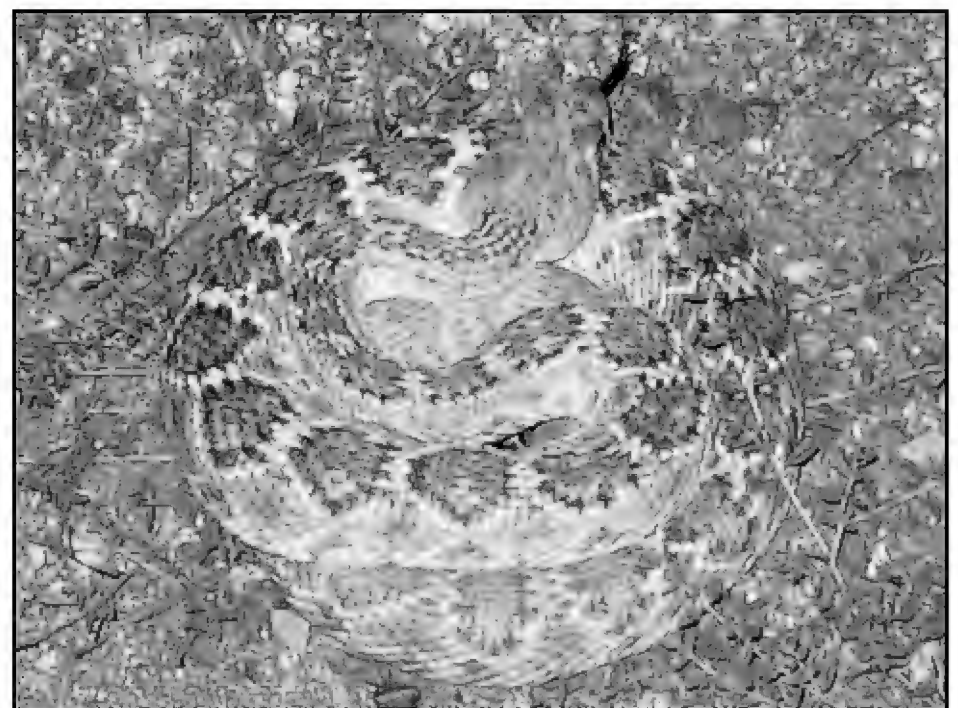


Figure 1. *Crotalus atrox* #102, “Ali,” as first viewed on the evening of 24 August 2006. She is coiled in a hunting/ambush posture. Note that the neck is cocked and loaded, ready to launch the head toward any unsuspecting prey item that scurries past. *Crotalus atrox* are commonly found coiled on wide open ground like this, hunting in this fashion. All images by the author.



Figure 2. During the process of taking data, Ali spooks and shifts to the right (northeast) of her coil/ambush spot. She circles undetected back to the west while the author busies himself with ink and paper. Note the slender distal flanks, indicating Ali has given birth recently.

takes to get moving in the direction of the nest is legendary. First off, nearly everything inside his backpack is spread around the countryside. It isn't science if one doesn't have a datasheet on a clipboard, a pen, a thermometer, and flagging scattered all across the area. Next, he adds a compass to the ground, a GPS alongside of it, and eyeglasses off so that both can be read. This having been done, everything must carefully be replaced in exactly the same spot from which it was removed. If one does not properly replace things exactly where they belong, further unnecessary flandickery may occur 15 minutes later—when it all might have to come back out again.

The result of the comparison of GPS to compass is that Ali is roughly 50 meters due east of her nest site. This means, of course, that the Tracker must move 50 meters west to get to the spot. He takes three steps westward, and finds an *atrox* coiled in his path. This situation sets up the entire gambit of flandickery associated with the finding of a new *atrox*. *Everything* comes back out of the pack, and snake tongs are made ready to make the grab. Before the bagging effort occurs, however, an impulse hits the Tracker. He plugs antenna into the receiver, cranks up the gain, and nearly blows his eardrums out of their moorings. The snake is signal 540—Ali again! She has obviously circled around him during the data process, and is watching all the flandickery associated with the first round of data from her new vantage point. She had duped him—crawling off one way, and then swinging quietly back the opposite direction. Since the Tracker had forgotten to do a rattle count with the initial hit, he takes a moment to hook the rattles out of her coiled form. She endures this without protest. The count is basal, skip two, cranberry-red, cranberry-red. She has not shed since June, which is normal. With the rattle check accomplished, everything is packed up again. He steps around Ali's coiled form, noting that her head tracks his every move as he does. Now he is moving west again, toward Ali's nest. And unbeknownst to the Tracker, so is Ali.

There are many prickly pear patches on the bajada below Li'l Hill—and they all look alike. He has traveled some distance since the last Ali encounter, and fears that he has blown past it. Out comes the compass and GPS, off go his glasses, and about five minutes of nocturnal flandickery in the inky blackness later, it is determined that he is dead on course. He is still about 20 meters east of the nest site. In order to remain dead on course,

he has to pass between two palo verde trees. Their canopy is arranged such that a narrow path of open ground exists between their low-lying canopy of stiff, unforgiving branches. And on this narrow patch of ground is the coiled form of an *atrox*. He may *never* get to this nest site!

All *atrox* look alike. But this one is looking mighty familiar. Just to be sure, the Tracker tries hooking the tail out of the coils. In response to the probing hook, the snake clenches. She tightens her coils to the point where there is no getting into them with a snake hook. She morphs into a ground-hugging snake Frisbee of sorts. The Tracker manages to get his hook under the clenched coils, and rolls her over on her back. She remains clenched through the process, a flat and tight spiral. The tail is compressed against the belly scales, but Ali's rattle colors (basal, skip two, cranberry-red and cranberry-red) can be plainly discerned. She promptly rights herself and regroups, coiling tightly in the center of the narrow path again. For the second time this night, she has done an end around on the Tracker! And, as before, she has placed herself between him and her nest site. This was getting downright spooky. Was she dogging him? Hell, yeah—she was stalking him! She was doing her best to thwart him from getting to her nest site. What was up with that?

"All right, cutes. Get out of my way, dammit," he growls at her. When that does not have the desired effect, he begins trying to gently push her under the canopy of one of the palo verde trees with his snake hook. She tightens up even more, hugging the stony ground with her belly scales, and will not be moved. Is this some form of passive resistance on her part? The thought of going around her occurs to the Tracker, but the pathway between the spike-riddled tree limbs is too narrow. To go around the trees would take him off his due easterly course. He is dead on with the Northing on his GPS unit—any sidestepping will result in epic fumbling to get back on track. He finally resorts to clamping her coiled body in his snake tongs, and gently places her behind him. He briskly covers the remaining distance to her nest site. Backwards glances occur every step of the way. The wench is stalking him! Snakes are not supposed to stalk people!

After all the effort to get here, the nest site is the usual disappointment. The Tracker slowly circles the prickly pear at least five times, carefully scrutinizing every nook and cranny for any signs of gossamer-thin shreds of snakeskin. Nothing but rat turds, soil holes, and heavily fortified, spine-infested pads meet his scrutiny. After ten minutes of this activity, he calls it done. When all is said and done, the write-up of Ali's pregnancy and subsequent nesting behaviors fell under the "went in fat, came out skinny, no other evidence of parturition occurring here" category. He could puke his disappointment. Ali's pregnancy was not entirely a bust, but close.

As he gathers his things to leave, a chance glance eastward reveals the coiled form of an *atrox* on open ground. She is about five meters from the eastern edge of the prickly pear nest site. How many times did he walk past her as he circled the prickly pear nest site? A quick signal check verifies that which he already knows. It's Ali. She had dogged him all the way back to the nest. There seemed to be no sense whatsoever in her actions, as everything that the Tracker had learned would indicate that the nesting action was over. For the second time that evening, the Tracker jumped to the conclusion that because momma was away from the nest, so were her young.



Figure 3. Overall gestalt of Ali's nest site, Gordon Schuett stands behind it all. 26 August 2006

Epilogue

Roughly 36 hours later, the good Dr. Schuett and I decided to check Ali's nest site one more time (Figure 3). Coming out of one of the soil holes at the stalk of her prickly pear fortress were two complete shed skins of neonate *atrox* (Figure 4). One other complete shed is in the center of the prickly pear, and one other is on open ground, one meter to the south of the nest canopy. There is no possible way that I (the Tracker) would have missed these shed skins on the evening of 24 August. Today, they stand out like the proverbial goat turds in the milking pail. The babies were there all along that night, they were just not showing themselves. The four shed skins are collected, bagged, and tagged. Ali is then tracked, and found very close to where she was on the evening of 24 August. At this point in time, mamma had left her nest site for good, as had her children. This time, the 2006 nesting cycle was finished for Ali.

Discussion

The importance of these shed skins appearing 36 hours after being followed by Ali is twofold:

1. The current wisdom regarding nesting female rattlesnakes staying with their young until their first ecdysis episode is not always 100% accurate. On the night in question, Ali was 50 meters from her nest, while her young were (likely) still in their underground nest hole.
2. Ali "knew" her young were still at the site. She was likely going to return at some point that night anyhow. During the many years that we have tracked pregnant female *atrox*, we saw them occasionally leaving and returning to their parturition sites while the young remained. (Schuett and Repp, unpublished data).

On top of all this, Ali *had* to be aware that I knew of her nest site. I was visiting the place several times a week while she went through her ordeal. If she knew that I knew where that nest site was located, the set-up for the event just described is complete.



Figure 4. Two of the four neonate shed skins that appeared roughly 36 hours after the incident described in the text occurred. 26 August 2006

Ali leaving the young in the nest while she hunted does not mean that she was a bad mother. If anything, I'm convinced that her actions on this night are indicative of a very strong maternal instinct. She was not only following me, she placed herself between me and the nest *twice*. On her second end around, the way she stubbornly tightened her coils into that Frisbee-like posture, refusing to leave on her own accord, is *hugely* atypical. Had she tried to hide her head in the process, it might have been considered a more typical reaction. But no, there was no attempt at head-hiding here. I've never seen anything like it! Eleven times out of ten, the slightest prodding causes an *atrox* to either flee, fight or, less often, hide their heads. Instead, she tried to hug that ground, and block the interloper from reaching her parturition site. The place that she made this stand also seemed downright strategic. I had to either go around her, or over top of her. It seemed that she knew where I was going, and did her best to divert me.

That final look I had of Ali watching me circle her nest site is one that I will never forget. It was a jolt of sorts, and somewhat chilling. What was that all about? This herper thinks he knows. Are these creatures capable of the complicated thought patterns demonstrated by Ali in this narrative? It appears so! It is the opinion of this author that Ali's actions on this evening displayed a form of intelligence above and beyond our current understanding of the thinking prowess of rattlesnakes. Concern of a mother rattlesnake over her brood is merely a pimple on the recent mountain of behaviors being documented by researchers across this hemisphere.

This here is Roger Repp, signing off from Southern Arizona, where the turtles are strong, the snakes are handsome, and the lizards are all above average.

Recommended Reading

A more scientific rendering of the preceding incident, with additional *excellent* input from Dr. Gordon W. Schuett, can be found here:

Schuett, G. W., R. A. Repp, C. L. Spencer, K. R. Beaman and C. W. Painter. 2016. Western Diamond-backed Rattlesnake (*Crotalus atrox*). Pp. 373-377. In: G. W. Schuett, M. J. Feldner, C. E. Smith and R. S. Reiserer, editors, Rattlesnakes of Arizona. Volume 1: Species accounts and natural history. Rodeo, New Mexico: ECO Publishing.

What You Missed at the February Meeting: Robin Warne

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Those of you who know me and those who have read my articles probably realize my intellectual capacity is somewhat . . . limited? Yeah, we'll go with that. I know that my column does not substitute for attending a meeting. I have neither the craft nor the brains to convey a summary of our monthly meetings to you in a matter that does those meetings justice, but I try. My aim is to convince you to attend the meetings, in spite of the traffic, the distance, the favorite TV show, or just the general lethargy we all succumb to at one point or another. I do exempt those of you who live outside of Chicagoland, but once a month seems doable even for those of you living in the outer burbs of the Chicago area. I write these articles attempting to convince you that you are missing something by not attending. Which you are.

I'm also trying to give you a hint of the remarkable speakers that show up at these meetings and the often-remarkable stuff that they're involved with. I and the other attendees get to chat with these people, ask them questions, and move in a world that is often far from what we know. Look back on the list of speakers on our web site and I doubt that anyone would not like to be mingling with the likes of these presenters. From academics to breeders to conservation workers to zookeepers (occasionally all combined in one person) we have a chance to peer into many different worlds that give us unique views into herps. All of that, plus a raffle, plus animals. For free. You need to be a member to receive this *Bulletin* and several other perks, but the meetings are always open to anyone and always free. And no one leaves knowing less than when they walked in. What a deal.

Dr. Robin Warne is one of those people who researches really interesting things. He was willing to spend two days away from home and 12 hours on a train to talk about some of what he's doing. He hails from Southern Illinois University in Carbondale, Illinois. Here's his biography from our web site:

Dr. Robin Warne is an Associate Professor at Southern Illinois University within the Department of Zoology. He received his PhD from University of New Mexico in 2008 and his Bachelors from University of California, Santa Cruz in 1996. He's a vertebrate physiological ecologist with a research focus on several inter-related topics that include: ecophysiology of homeostasis in a changing world, environmental stress and emerging disease interactions, the physiology of animal interactions in ecological communities, and the roles symbiotic microbiota play in animal development and disease. In his research he works with a diversity of taxa that includes amphibians, reptiles, rodents, and insects. Currently his lab is exploring how developmental plasticity, physiological performance, and disease across ontogeny in amphibians are determined by interactions between neuroendocrine function and gut microbiome dynamics, how physiological homeostatic function (stress hormones, osmoregulation, immune function) in rodents influences their behavior and foraging, and subsequently alters plant community ecology. They are also testing how variation in essential fatty acid availability influences performance in snakes. Last, they are exploring the ecological and physiological factors underlying epizootic outbreaks



Dr. Robin Warne. Photograph by Dick Buchholz.

of ranavirus—an emerging disease of ectothermic vertebrates.

I meet few researchers who are satisfied pursuing one topic, and all seem to come up with results that only lead to more questions. I think that defines a good scientist. Someone who is always asking questions. Dr. Warne is an obvious example of the consummate investigator, and he was good enough to give us overviews of several of his studies.

Robin started out by reminding us of how wild and wacky amphibians are, particularly anurans. With a cool slide showing the developmental stages of a wood frog (*Rana sylvatica*), a gorgeous photo of tadpoles swimming through a swamp, and a drawing of froglets emerging from a pouch-brooding frog, he led us through interesting findings and new questions concerning marsupial frogs. Is there developmental plasticity or facultative nutrient transfer and might a study of these frogs lead to better understanding of the evolution of viviparity? Using feeder insects laced with isotopes, Robin and colleagues not only found those isotopes in the embryos, but also found that the embryos actually increased in mass before hatching. Seems that nutrient exchange between mother and embryo definitely occurs.

Anurans go through complex physiological changes from egg to adult. During that development period there are critical windows that affect phenotypes. The factors affecting those changes and the windows are many and varied. Robin wanted to know if ranavirus had a critical window in its effect on amphibian embryos. Along with cool but disheartening photos of the victims of ranavirus, he gave us a brief summary of the disease he called, “one hell of a scary beast.” It's a globally distributed pathogen known to cause mass die-offs in many ectothermic animals, and it's nearly always fatal. It is difficult to know if this disease is an emergent disease or one that we haven't noticed before because it frequently wipes out a population before anyone can observe the effects. Robin has shown that in anurans ranavirus is a stage-dependent disease with the window of vulnerability around the time of metamorphosis. Larval frogs seem to escape the ranavirus by metamorphosing. Robin found that ranavirus infections increase the levels of corticosterone (CORT) in tadpoles. CORT is a steroid hormone involved in the stress response of many animals. Increased CORT levels led to some interesting effects. The energetic costs of metamorphosis are increased by the presence of ranavirus and CORT and the pre-infection metabolic rate is a reliable predictor of survival time. High stress might be a positive factor if the embryo metamorphoses faster and moves through the widow of vulnerability.

Dr. Warne also wanted to see if the embryos' gastrointestinal microbiomes (GIMs) affected ranavirus. He used wood frog eggs that had been subjected to three different treatments,

namely: eggs that had been cleaned of their microbiome, eggs that had their natural microbiota, and eggs that had been bathed in the GIM of bullfrogs (*Lithobates catesbeianus*). Bullfrogs “are like tanks.” They are particularly resistant to ranavirus and develop faster than wood frogs. He found that the bullfrog-inoculated eggs did develop faster than the others, but survival rate from the ranavirus varied little between the native GIM treatment and the bullfrog GIM treatment. The eggs stripped of their GIM were nearly three times more likely to die than the native wood frog GIM and developed abnormal tails at a greatly increased rate.

Dr. Warne’s studies are not limited to amphibians of course. He began noticing common factors driving emerging epizootics. White-nose fungus in bats, ranavirus in ectotherms, chytridiomycosis in amphibians, and snake fungal disease all seem to lead toward a commonality of complexity in the life histories of infected animals. Bats and reptiles hibernate, and amphibians metamorphose. The diseases seem to strike at certain times

when the animals are most vulnerable, during hibernation or metamorphosis. Robin has begun working on a “window of vulnerability” model that may provide a means of focusing hypotheses and tests of environmental forces shaping emergent diseases. I won’t write about that model because he hasn’t published yet, but it was an interesting proposition.

Robin’s talk was interesting and intriguing. His research has certainly posed questions, many of which I’m sure he will be pursuing in the future. I’m sorry you missed much of what else he had to say, such as the warnings to not drink frog milkshakes in Peru or how he inoculated wood frog eggs with bullfrog microbiota. You missed an engaging conversation over dinner after the meeting. During a pleasant ride to his hotel afterwards, I discovered that he’s a martial arts instructor. I hope we have the chance to field herp with him on future trips to southern Illinois. We appreciate his visit to Chicago and our society. Come to a meeting and you’ll be able to hang out with people like Robin.

Minutes of the CHS Board Meeting, February 16, 2018

Rich Crowley called the meeting to order at 7:38 P.M. Board members Dan Bavirsha, Lawrence Huddleston, Kim Klisiak and Jessica Wadleigh were absent. The minutes of the January 19 board meeting were read and accepted.

Officers’ Reports

Treasurer: John Archer read through the financial reports.

Membership secretary: Mike Dloogatch read the list of expiring memberships.

Sergeant-at-arms: There were 40 people at the January 31 meeting.

Committee Reports

ReptileFest: Frank Sladek reported that Bob Bavirsha has spoken with Chicago Animal Care and Control about our permit. CACC will have a table at ’Fest this year.

Adoptions: Zorina Banas will be assisting Linda Malawy with the CHS animal adoptions program.

Junior Herpers: Frank Sladek reported that 40 people were present at the February meeting.

Grants committee: The committee will meet in February 17 to choose the recipients.

Old Business

We are still looking for a permanent venue at which to hold the board meetings.

There was a discussion emphasizing that all exhibitors at ReptileFest or other CHS shows must follow the written guidelines.

New Business

We received a written notice that a new tax will be charged on our rented storage unit and parking space. It was unclear what this would amount to. We will check into it.

The consensus of the board was to continue our membership in Chicago Wilderness by paying our annual dues.

The meeting adjourned at 9:11 P.M.

Respectfully submitted by recording secretary Gail Oomens

Advertisements

For sale: **highest quality frozen rodents.** I have been raising rodents for over 30 years and can supply you with the highest quality mice available in the U.S. These are always exceptionally clean and healthy with no urine odor or mixed in bedding. I feed these to my own reptile collection exclusively and so make sure they are the best available. All rodents are produced from my personal breeding colony and are fed exceptional high protein, low fat rodent diets; no dog food is ever used. Additionally, all mice are flash frozen and are separate in the bag, not frozen together. I also have ultra low shipping prices to most areas of the U.S. and can beat others shipping prices considerably. I specialize in the smaller mice sizes and currently have the following four sizes available: Small pink mice (1 day old—1 gm) , \$25 /100; Large pink mice (4 to 5 days old—2 to 3 gm), \$27.50 /100; Small fuzzy mice (7 to 8 days old—5 to 6 gm) , \$30/100; Large fuzzy mice / hoppers (10 to 12 days old—8 to 10 gm), \$35/100 Contact Kelly Haller at 785-234-3358 or by e-mail at kelhal56@hotmail.com

For sale or trade: Probable pair of albino Harquahala rosy boas. They were born in my home in late 2016 and are feeding on f/t peach fuzz mice. Pure locality animals exhibiting a recessive gene. Viewing is possible, parents on site. I can drive to meet a reasonable distance, or ship if you are not local. Discount if you pick them up from my home. Cash, credit card or PayPal. Call or text 510-318-1715, or email elenabmoss@gmail.com.

Herp tours: **Costa Rica herping adventures.** Join a small group of fellow herpers for 7 herp-filled days. We find all types of herps, mammals, birds and insects, but our target is snakes. We average 52 per trip, and this is our 10th year doing it. If you would like to enjoy finding herps in the wild and sleep in a bed at night with air-conditioning, hot water and only unpack your suitcase once, instead of daily, then this is the place to do it. Go to our web-site <http://hiss-n-things.com> and read the highlights of our trips. Read the statistics of each trip and visit the link showing photos of the 40 different species we have found along the way. E-mail at jim.kavney@gmail.com or call Jim Kavney, 305-664-2881.

Line ads in this publication are run free for CHS members — \$2 per line for nonmembers. Any ad may be refused at the discretion of the Editor. Submit ads to mdloogatch@chicagoherp.org.

NEW CHS MEMBERS THIS MONTH

Alexandra & Patricia O'Keefe

David A. Osborne

Robin Warne

Karina Mikols

Allen Jaross

From the company that developed the **first UVB lamp** for reptiles 20 years ago...

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Midwest Herpetological Symposium

New This Year!!!

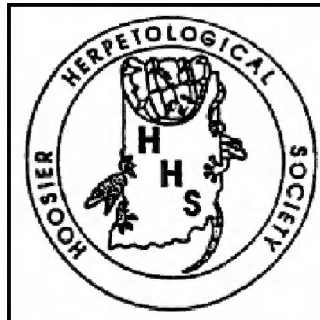
Award for Young Herpetological Enthusiasts!!!

The Midwest Herpetological Symposium announces the creation of a new award for young herpetologists and herpetoculturists.

In each of two age categories (12–14 and 15–17), awards will be given for FREE full registration to the best annual herp conference in the Midwest in addition to a cash stipend towards travel expenses.

Don't miss this wonderful opportunity to attend the Midwest Herpetological Symposium (this year in Indianapolis, September 28–30), learn lots, and meet some GREAT herpers!

For more information and complete award rules, please contact the Hoosier Herpetological Society at president@hoosierherpsoc.org or Theresa Moran at oldherper@tds.net.



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UPCOMING MEETINGS

The next meeting of the Chicago Herpetological Society will be held at 7:30 P.M., Wednesday, March 28, at the Peggy Notebaert Nature Museum, Cannon Drive and Fullerton Parkway, in Chicago. The speaker will be **Yatin Kalki**, an undergraduate student at the University of Illinois at Urbana-Champaign. Yatin grew up in the urban megacity of Bangalore, India, where at the age of 17 he started catching and relocating snakes that found their way into his neighbors' houses. He then went on to assist herpetologists in the Western Ghats, a mountain range in South India which is considered a biodiversity hotspot of the world. His talk, "Herping in Southern India," will first focus on his experiences herping in the highly urbanized landscape of Bangalore and then move on to the pristine rainforests of the Western Ghats and herpetofauna found there.

Speaking at the April 25 meeting will be **Dr. Tony Colbert**, a veterinarian who practices at the Ness Exotic Wellness Center in Lisle, Illinois.

The regular monthly meetings of the Chicago Herpetological Society take place at Chicago's newest museum—the **Peggy Notebaert Nature Museum**. This beautiful building is at Fullerton Parkway and Cannon Drive, directly across Fullerton from the Lincoln Park Zoo. Meetings are held the last Wednesday of each month, from 7:30 P.M. through 9:30 P.M. Parking is free on Cannon Drive. A plethora of CTA buses stop nearby.

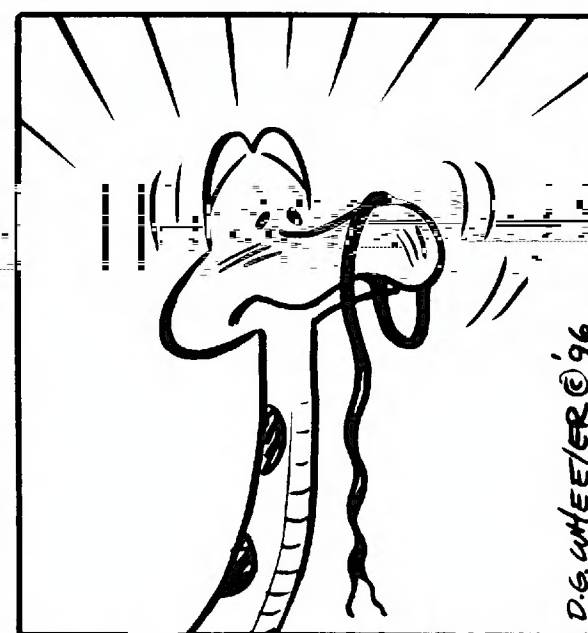
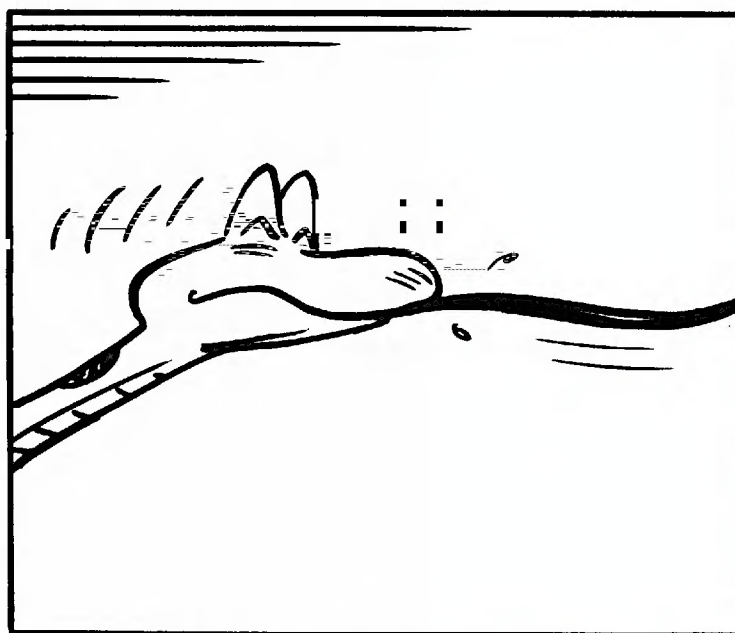
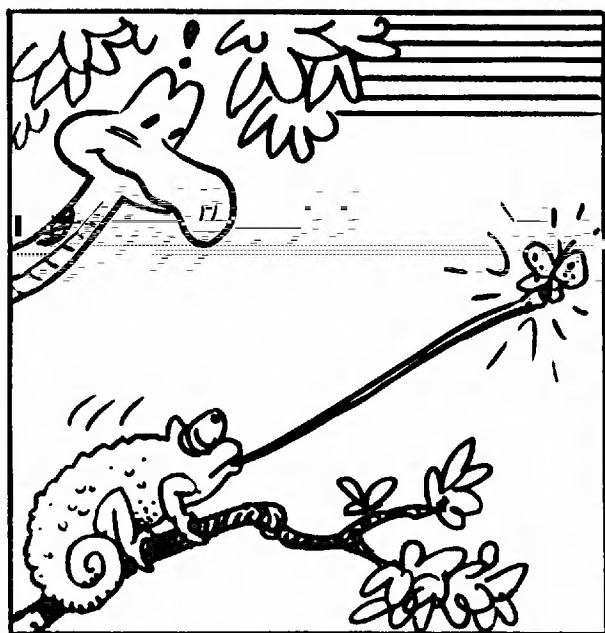
Board of Directors Meeting

Are you interested in how the decisions are made that determine how the Chicago Herpetological Society runs? And would you like to have input into those decisions? If so, mark your calendar for the next board meeting, to take place on April 13, 2018. The venue is as yet uncertain, so if you wish to attend please email mdloogatch@chicagoherp.org.

The Chicago Turtle Club

The monthly meetings of the Chicago Turtle Club are informal; questions, children and animals are welcome. Meetings normally take place at the North Park Village Nature Center, 5801 N. Pulaski, in Chicago. Parking is free. For more info visit the group's Facebook page.

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